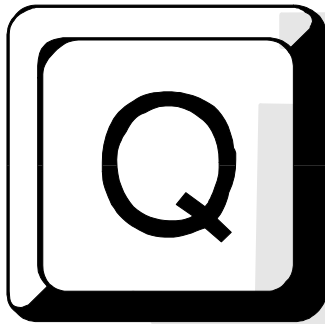

TPRS

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Quarterly Report

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President's Report Tom McDermott, N5EG

Hamcom 2002 will be held at the Arlington convention Center on Friday, June 7th, and Saturday June 8th. The convention will not be open on Sunday this year. TPRS will hold it's annual meeting at 7:00 PM, Saturday, June 8th at the On The Border restaurant, located within walking distance of the convention center, at Copeland Road and Ballpark Way. Everyone is invited. Election of directors will be held; two director positions are open this year.

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TPRS will not have any programs at this year's convention due to busy work schedules, and we will not have

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Quarterly Report

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any meeting space in the convention center where we normally hold the annual meeting (hence the meeting at the restaurant).

Still nothing additional to report on the FHSS project – it's at a standstill, due to lack of progress on the RF part. If you have an interest in the project, and are technically capable of RF design or debugging in the 900 MHz. range – please let me know right away (n5eg@tapr.org). We are working a few important component obsolescence issues on the digital board.

In the rest of this issue, we will continue the discussion on “Zero-IF” technology. In part 1 we discussed the technique, part 2 discusses some limitations of quadrature direct conversion, and approaches to addressing these limitations.

Part 8 of Wireless LAN Resources for LINUX will appear in a future issue of the QR.

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Modern “Zero-I.F.” Technology, Part 2

In part one of this series, we discussed the use of quadrature up and down conversion techniques to dramatically simplify VHF and UHF RF equipment for data. While the Zero-IF technique works well for transmission, unfortunately the Zero-IF receiver has a couple of serious drawbacks.

The most serious problem is *DC-Offset*. DC Offset is caused by leakage of the LO into the down converter input. The phase and amplitude relationships between the leakage components and the LO itself are relatively constant. The product (mixing) of two signals with the same frequency is a DC offset proportional to the phase difference between the signals. While not a problem with voice or CW modulation decoded as an audio tone (which do not contain DC or very-low frequency modulation components), pseudo-random data contains very low frequency components. This means that a simple high-pass-filter does not work well in separating the DC component from the desired data sidebands.

Because the offset is caused by self-mixing of the local oscillator (LO) with the received signal, and the LO is at the same frequency as the received signal, it's impossible to completely filter it out from the RF amplification chain (or the mixer RF input). The LO radiation can be due to

buffer radiation, imperfect mixer balance, or other leakage mechanisms (such as stray circuit parasitics on the mixer chip itself).

It's common for down-conversion quadrature mixers to accept LO injection input at twice the actual LO frequency. Then the mixer chip divides the injected frequency by 2, which both simplifies the I/Q quadrature L.O. generation process while minimizing the coupling of the externally injected frequency into the R.F. stages. Thus the undesired coupling of the on-frequency is completely under control of the mixer integrated circuit layout and parasitic/stray circuit elements and mixer balance.

One approach to removing the DC offset is to use digital signal processing to subtract the constant offset from the data bursts. This requires that the DC offset be stable over the duration of one (or several) data bursts. This problem and associated techniques are documented in the literature^{1,2,3,4}.

¹ Dorfan, Y., “High-speed data in EGPRS – A physical layer challenge”, RF Design, pp 26-34, May 2002.

² Lindoff, B., “Using a direct conversion receiver in EDGE terminals – A new DC offset compensation algorithm”, PIMRC Conference, September 2000.

³ Lindoff, B., and Malm, P., “A design rule for DC compensation in direct conversion receivers”, 2001 International Conference on Third Generation Wireless and Beyond.

Another approach to removing the DC component is to convert the received signal to almost baseband, the so-called *near-zero-IF* technique. In this case, the received signal is tuned to a slightly different frequency than the actual frequency.

Since both I & Q LO and baseband signals are present, it's possible to resolve the carrier under the condition that the frequency difference is greater than the modulation bandwidth. The received signal is *de-rotated* with a complex I/Q multiplier. The derotation process is the same as shifting the frequency up (or down) [similar to tuning a single sideband receiver, not like mixing]. As the baseband signal is shifted in frequency back to the desired frequency, the DC offset is shifted to a single frequency interfering carrier (equal in frequency to the amount of shift). As long as this shifted carrier ends up outside the modulation passband, it can be filtered with a lowpass filter – in fact the same lowpass filter that is normally used to shape the receive noise spectrum (e.g. a raised cosine filter).

The drawback with the *derotation* technique is that the A-to-D converters in the baseband digitization process have to operate at

a higher sampling rate than the Nyquist rate ($2x$) which is possible when the ADC sampling is phase-locked to the receive symbols.

(The TAPR FHSS baseband board receives a super heterodyne down-converted signal, but it actively phase-locks the ADC clock to the received symbols at $2x$ the symbol rate. This reduces the DSP processing load to the minimum possible rate. It also de-rotates the received signal, but in this case only to compensate for T/R frequency errors).

An additional problem with direction conversion receivers is AM detection. Any 2^{nd} order non-linearities in the RF amplifier or coupling from the RF input to the mixer output stage will cause the envelope of the mixer input to vary. The output of the mixer will thus vary in the same way (since it's output is proportional to the product of the input and the LO), and the amplitude modulation will be detected on the output. A strong enough signal with amplitude variations anywhere in the RF passband of the receiver will cause AM modulation of the baseband output. This problem is well known with simple QRP receiver designs. Receivers with an IF bandpass filter remove this low frequency envelope from the IF signal, and thus do not suffer from the problem.

Available Components

⁴ J. Strange, D. Grant, "Direct Conversion: No Pain, No Gain", Communications Systems Design, Apr 2, 2002, url:<http://www.commsdesign.com/story/OEG20020402S0032>

Analog devices has released the AD8347 quadrature down-converter⁵, which operates from 800 MHz. to 2.7 GHz., thus covering 3 amateur bands. It's unusual in that the LO is the same frequency as the mixer injection; the phase splitting is accomplished via cascaded broadband phase splitting networks. The LO needs to be injected differentially to minimize LO to RF leakage.

The AD8347 also contains AGC and active DC-offset cancellation circuits. The DC-offset has a time constant set with a single-pole filter, and it needs to be a lot lower than data rate (otherwise the data itself will modulate the apparent offset voltage) but a lot higher than the burst rate.. The app note doesn't discuss the AGC timing, unfortunately. For the TAPR FHSS radio application the time constants of the DC offset cancellation appear possibly to be within the range of desired values.

The noise figure of the part ranges from about 10.2 db at 800 MHz. to 12.5 db at 2700 MHz, so a good RF amplifier is necessary. Since the part has up to 70 db of RF gain (with the AGC wide open) stability of the RF stages may be a real concern.

Conclusion

Recent chips have appeared based on direction quadrature down

conversion. While simple, low power, and relatively inexpensive, they pose some significant receiver processing issues.

The current state-of-the art now requires about 5 RF ICs and a lot of discrete parts to implement a cellular handset. We can hope that increasing integration and performance will reduce this to 2 ICs (one Tx, one Rx) at some point in the future. This would eliminate many of the discrete components, and make the application and experimentation by hams easier and more practical than today's more complex designs.

Examples of transmit up conversion and receive down conversion ICs have been presented in this two-article series.

⁵ AD8347 datasheet, Rev 0. url:
<http://www.analog.com>

Digital Mode UHF and VHF Band Plans

The Texas VHF-FM Society, Inc. adopted in February 1987, and revised in February 1988, band plans for the 2 meter and part of the 70 centimeter band in Texas. The general membership of the VHF-FM Society adopted these plans in August 1991, and revised in 1999. These plans determine where digital and packet modes are authorized to operate in Texas. The portions most applicable to packet and digital operation are underlined.

Normal (customary) digital usage, and clarification of the VHF-FM Society tables have been added by the QR. Please report any errors to the TPRS QR editor. These plans are printed with the permission of the Texas VHF-FM Society, Inc.

144 - 148 Mhz Band Plan

144.000 - 144.100	CW (The FCC assignment for 2 meters specifies this)
144.100 - 144.275	Weak Signal SSB (144.200 is the SSB calling frequency)
144.275 - 144.300	Propagation Beacons
144.300 - 144.500	Satelite Sub-band
<u>144.390</u>	<u>APRS - Automatic Position Reporting System (Note: 1200 baud AFSK is normally used)</u>
144.510 - 144.890	Repeater Inputs - paired with 145.110 - 145.490 Outputs
<u>144.900 - 145.100</u>	<u>Packet (Note: 1200 baud AFSK is normally used)</u>
145.110 - 145.490	Repeater Outputs - 20 Khz spacing on the odd 10 Khz channels
145.500 - 145.800	Simplex and Experimental
145.800 - 146.000	Satelite Sub-band
146.020 - 146.400	Repeater Inputs - paired with 146.620 - 147.000 outputs
146.400 - 146.600	Simplex (146.520 is the FM national calling frequency)
146.620 - 147.000	Repeater Outputs - 20 Khz spacing on the even 10 Khz channels
	Paired with 146.020 - 146.400 inputs
147.000 - 147.380	Repeater Outputs - 20 Khz spacing on the even 10 Khz channels
147.400 - 147.600	Simplex
147.600 - 147.980	Repeater Inputs - paired with 147.000 - 147.380 outputs

440 - 450 Mhz Band Plan

440.000 - 440.500	Digital Wideband Output (50 or 100 Khz wide)
440.525 - 440.725	Digital narrowband repeater Output (Note: 1200 baud AFSK is normally used)
440.750 - 440.975	Cross band repeat - fixed
441.000	Narrowband packet (Note: 1200 baud AFSK is normally used)
441.025 - 441.075	Simplex NBFM Voice
441.100 - 441.175	Simplex Narrowband digital (Note: 1200 baud AFSK is normally used)
441.200 - 441.275	Control channels (12.5 Khz spacing)
441.300 - 441.375	"Backyard" Repeater Output
441.400 - 441.475	Control channels (12.5 Khz spacing)
441.500 - 441.975	Low power NBFM Repeater Output
442.000 - 444.975	NBFM Repeater Output (25 Khz spacing)
445.000	NASA Select NBFM Audio
445.000 - 445.500	Digital Wideband Input (50 or 100 Khz wide. Note: scrambled 9600 baud direct FSK is normally used)
445.525 - 445.725	Digital Narrowband repeater Input (paired with 440.525 - 440.725, 25 Khz. spacing).
445.750 - 445.975	Crossband repeat - mobile
446.000	National Simplex NBFM calling frequency
446.025 - 446.075	Simplex NBFM voice
446.100 - 446.175	Simplex narrowband digital (25 Khz spacing. Note: 1200 baud AFSK is normally used)
446.200 - 446.275	One-way links (split site repeaters)
446.300 - 446.375	"Backyard" repeater input (25 Khz spacing, paired with 441.300 - 441.375)
446.400 - 446.475	One-way links (split site repeaters)
446.500 - 446.975	Low power NBFM Repeater Input (25 Khz spacing, paired with 441.500 - 441.975)
447.000 - 449.975	NBFM repeater input (25 Khz spacing, paired with 442.000 - 444.975)

Texas Packet Radio Society, Inc.

TPRS was founded in 1985 and is an educational, public service, and scientific research non-profit corporation. Texas Packet Radio Society goals are:

- 1- design and research amateur radio packet networks
- 2- provide education in the area of general packet usage

To accomplish better communications in the region, TPRS has been organizing statewide working groups to cover various networking topics. The current working groups are the Mailbox/BBS Group, TCP/IP Group, and the TexNet Support Group. TPRS hopes that these working groups will help promote information exchange in their respected areas in Texas. New working groups are formed as needed to provide channels for discussion and to help provide direction for that area of digital communications. Anyone can participate in a working group; TPRS membership is not required.

TexNet

TPRS has established a digital packet network protocol, a standard hardware package for the network nodes, and software modules that implement the TexNet network.

The basic design philosophy of TexNet is an open, inexpensive, multi-resource, high speed 'backbone' with access through multi-connect capable local nodes. On the high speed side, TexNet is a 9600 baud network system. For local access, compatibility with the typical 2 meter AX.25, 1200 baud, AFSK/FM station is the operational norm. Other baud rates and modulation techniques can be supported on the primary user port or secondary port. The system is totally compatible with both versions of the AX.25 protocol specifications for user connections. With these general specifications, TexNet has been designed and tested to enable all users to take advantage of this high speed, full protocol protected packet network system.

Each node offers, in addition to TexNet access, local area digipeater service, 2 conference bridges for full protocol protected roundtable or net operation, a full multi-connect, multi-user mailbox system, a local console for installation and maintenance setups, a debugger module for long distance and local software monitoring, and an interface for a weather information server for regional weather information, if available.

The NCP-PC (TexNet for PC) creates a direct interface to the PC platform. The Z80 based PC card supports 4 channels for communications. This co-processor approach allows the AX.25 and TexNet-IP to run on the card without affecting the PC. This allows the full power of the PC to be used for network applications. The versatility of this board is only now being developed and applications are endless.

The TexNet Network

The Texas TexNet network system has been operational since October 1986. When fully operational, the network reaches from the border of Mexico to Missouri. Use of the Texas TexNet system is open to all amateur operators. TPRS has been coordinating the installation of the Texas TexNet system. Further expansion of the system depends entirely upon the amateur community.

INFORMATION

TPRS is interested in spreading our information and research efforts as widely as possible. We want other groups involved with packet efforts to get in contact with us. We will provide information for those amateur packet groups that are interested in this system for their areas. If you would like more information concerning TPRS or TexNet, please drop a letter to:

Texas Packet Radio Society, Inc.
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Austin, Texas 78765-9142

TPRS MEMBERSHIP

TPRS membership is widespread with most members located in Texas, but members are located in other states and in foreign countries. Membership is open to any interested person. If you are interested in becoming a member and receiving the TPRS Quarterly Report, please send your name, address and call with membership dues of \$12 per year.

TPRS Membership Application

Name _____ Callsign _____

Address _____

Apt. or Mailstop _____

City/State _____

Zip _____ E-mail address _____

Evening Phone () _____ Work Phone () _____

Membership is \$12 per year. How many years are you paying for? _____

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